RESPIRATORY ORGANS OF CHIGGERS

(ACARINA)

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Brennan (1949) has reviewed the few papers that have discussed the respiratory systems of larval trombiculids and has described the system as it occurs in *Acomatacarus arizonensis* Ewing, 1942. Up to the present, knowledge of the respiratory system in larval trombiculids can be summarized as follows: respiratory systems have been reported in species belonging to the subfamilies Apoloniinae and Leeuwenhoekiinae; none have been reported for the Trombiculinae and Walchiinae. The respiratory systems of three species of the leeuwenhoekiinid genus Acomatacarus have been studied (André, 1943; Hoffmann, 1948; Brennan, 1949) and all have been found to consist of a pair of stigmata lateral to the gnathosoma, each of which connects with a single, long, convoluted, unbranched tracheal tube. The respiratory systems of other species have not been carefully analyzed.

Studies on the respiratory systems of larval and adult trombiculids made at Duke University have raised questions concerning the common interpretation of these structures in the trombiculids. Brown (1949) in a study of the adult traced the tubes that open on the atrium of the adult *Trombicula alfreddugèsi* (Oudemans), 1910. These tubes or ducts were supported by taenidia and had the appearance of tracheae. However they terminate or disappear in glandular tissue so it is possible that they are actually ducts or glands, possibly salivary glands. A similar condition may exist in the larva of *Apolonia tigipionensis* Torres and Braga, 1938 André (1929) studied the respiratory system of the nymph of *Trombicula autumnalis* (Shaw), 1790 and reported branching tracheae that opened on the basal segment of the chelicerae. No such structures were found by Brown (1949) in *Trombicula alfreddugèsi*. No experimental evidence has yet been obtained to demonstrate that the so-called tracheae of trombiculid mites are in fact respiratory organs. Any tube with taenidia has been assumed to be a trachea.

Recently two specimens of a new species of *Neoschöngastia* were received from R. W. Strandtmann. Both of these specimens were found to have branching tubes that resembled tracheae. The presence of a so-called respiratory system in these specimens upset the concept of the structure of the subfamily Trombiculinae in as much as the other members of the subfamily were not known to have such tubes. This discovery

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led to a reexamination of specimens available at Duke, that were reported to have respiratory systems. Examination of some specimens mounted in PVA failed to reveal the tubes that had been seen previously. Even with the phase contrast microscope no remnant of the tubes could be seen in some species while in others only faint traces could be seen. Evidently PVA completely destroys them in a relatively short time. Specimens mounted in damar or chloral hydrate did show at least parts of the system in question. Clarification of some provisional and erroneous statements made in the literature can now be made.

Wharton (1946) proposed that a pair of median skeletal structures, since found at the base of the chelicerae in all chiggers, might represent sclerotized tracheal trunks; because similar structures are known to contain the tracheae in adults of *Allothrombium*, a genus that belongs to the closely related family Trombidiidae. Examination of a preparation made by Radford of *Neoschöngastia mirafra* Radford, 1942 that is now in the U. S. National Museum showed that these structures are in reality cheliceral apodemes. In Radford's preparation, the chelicerae have broken away from the gnathosoma and the apodeme has remained attached. Brown (1949) has described the apodeme in the adult of *Trombicula alfreddugèsi*. Comparison of the adult apodemes of *Trombicula* with those of *Allothrombium* demonstrates that the tracheae of *Allothrombium* actually run through the cheliceral apodemes. Henking (1882) presents a clear account of the relationship between the tracheal system and cheliceral apodemes of *Allotrombium fuliginosum* Hermann, 1804 although he does not recognize the heavily sclerotized sections of the tracheal trunks as cheliceral apodemes.

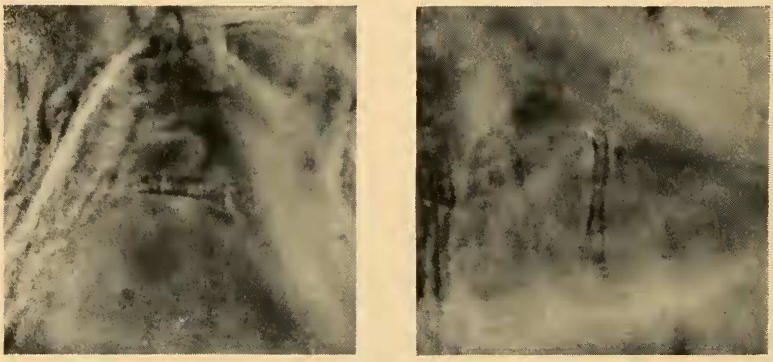
The two known species of the subfamily Apoloniinae, *Apolonia tigipionensis* and *Womersia straudtmani* Wharton, 1947 were reexamined with a phase contrast microscope. Wharton (1947) mistook a fold in the integument between the gnathosoma and coxa I of *Womersia straudtmani* for the stigma and a portion of the trachea. Actually the tube does not open to the outside here but extends to the dorsal wall of the gnathosoma just beneath the basal segments of the chelicerae where it terminates at the anterior lateral corner of a sclerotized chamber that is reminiscent of the adult atrium as described by Brown (1949). A second tube previously unreported also extends from the posterior lateral corner of the atrium. The tube that leaves the posterior corner runs posteriorly, branches and disappears before leaving the gnathosoma. The tube from the anterior corner extends laterally and posteriorly. It branches at least twice and can be followed

back to the level of coxa II as indicated by Wharton (1947, Figure 1 E). A drawing of the tubes as they appear on the left side of a specimen is given in Figure 1. The condition in *Apolonia tigipionensis* is probably similar to that found in *Womersia strandtmani*. It was impossible to trace the main tube from the lateral side of the gnathosoma to the atrium with any degree of certainty. It was possible, though, to see that the so-called tracheae terminated in expanded sacs. Four branches from the main tube on the left side were detected. These are shown in Figure 2 and Plate I.

The structure of the tracheal systems of *Acomatacarus* and *Whartonia* was not found to differ from previous reports of Brennan (1949), Hoffmann (1948), or André (1943). None of the specimens of *Acomatacarus* showed the repiratory system as clearly as that figured by Brennan. In one specimen of *Whartonia nudosetosa* (Wharton), 1938 the tracheae could be traced as far as coxa III. Figure 3. No evidence of branching of tracheae as reported by Womersley (1945) was found in these two genera, but the tracheal system of *Hannemania dunni* Sambon, 1928 (Figure 4) was found to be similar to that of the Apoloniinae.

The system of tubes supported by taenidia seen in the specimens of *Neoschöngastia* mentioned above were similar to those found in the Apoloniinae. These specimens, however, were mounted in PVA, and after six months the tracheae can no longer be seen clearly even with the aid of a phase contrast microscope.

Discussion: On the basis of the evidence reported here and that found in the literature it is apparent that there is more than one type of tube supported by taenidia to be found in



TEXT FIGURE 1. The ducts of *Apolonia tigipionensis:* A. The main duct, B. The termination of the ducts. See Figure 2.

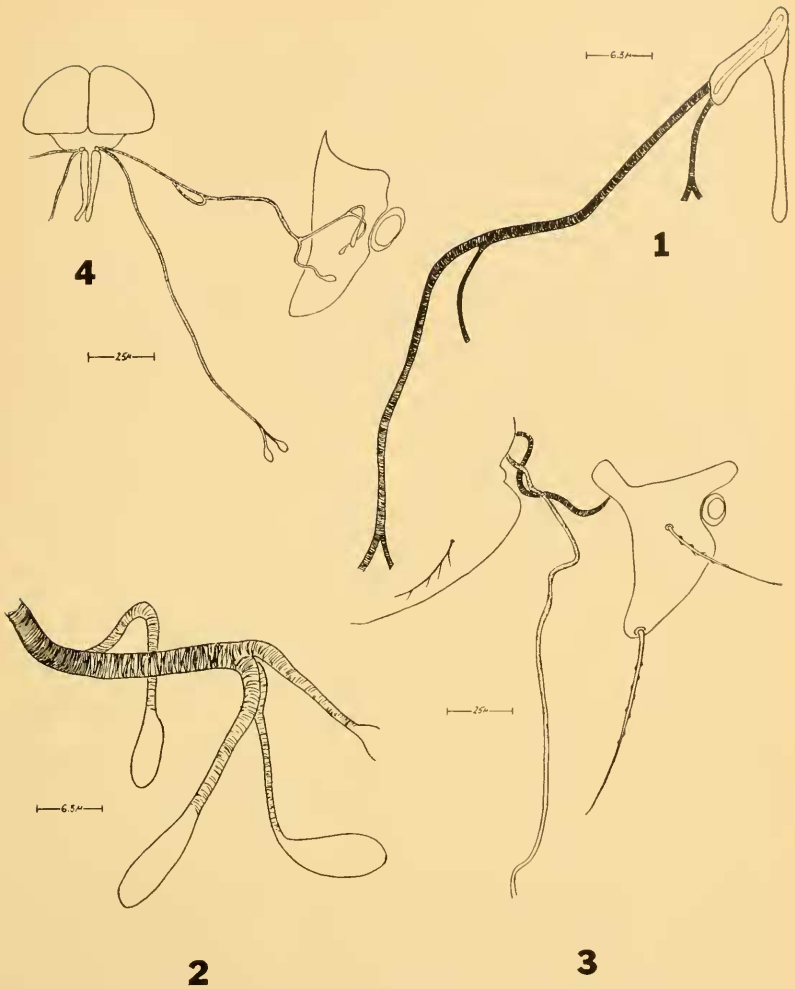


PLATE 34. RESPIRATORY SYSTEM OF CHIGGERS

Fig. 1. Ducts of *Womersia strandtmani* opening into the atrium on the left-hand side. The structure shown beneath the atrium is the left cheliceral apodeme. The branching of the ducts is clear but tehir manner of termination could not be determined on the available specimens. Fig. 2. The ends of the ducts in *Apolonia tigipionensis*, the ducts could not be traced to the atrium. Fig. 3. The duct on the left side of a specimen of *Whartonia nudosetosa.* Coxa I and the base of the gnathosoma are shown. The spiracle could not be seen, nor could a connection between the duct with heavy taenidia and lighter taenidia be demonstrated. Fig. 4. The ducts of *Hannemania dunni.* Notice their similarity to those of *W. strandtmani* and *A. tigipionensis.*

the Trombiculidae: the type found in the nymph of *Trombicula autumnalis* by André (1929); the type reported by Brown (1949) for the adult of *Trombicula alfreddugèsi* which is probably similar to the type reported here for *Apolonia tigipionensis*, *Womersia strandtmani*, *Neoschöngastia*, n.sp., and *Hannemania dunni;* and finally the type reported for larvae belonging to the genera *Acomatacarus* and *Whartonia*. It is impossible to say at the present time whether or not these structures are respiratory organs. All, some, or none may be.

Womersley (1945), Ewing (1946), and Wharton (1947) have all used the presence or absence of a respiratory system as a diagnostic characteristic in differentiating the subfamilies of the Trombiculidae. Lawrence (1949) points out some of the inconsistencies involved in the use of this characteristic since it is not a constant feature in all of the subfamilies. The fact that the so-called respiratory system are fundamentally different structures may resolve some of the former difficulties. It is suggestive that the known nymphs and adults of the genus *Hannemania* are more like those of the Trombiculinae than those of the Leeuwenhoekiinae. Much additional information will have to be obtained before a completely satisfactory classification of the Trombiculidae is achieved.

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BOOK REVIEW

THE MAYFLIES OF FLORIDA, by Lewis Berner. 267 + 12 pp., 24 pls., 88 text figs., 19 maps. University of Florida Press, Gainesville, Fla. 1950. $5.50, paperbound.

The state of Florida is not an area rich either in species or individuals of mayflies, yet, by diligent collecting and rearing throughout the state, Dr. Berner has been able to accumulate Florida records of 48 species. This number of species might, at first glance, seem small, but it should be borne in mind that there are only some 550 species of mayflies known for all North America, and the great bulk of them are strictly northern in distribution. Furthermore, Florida has relatively few different types of habitats where mayflies may develop. The state of Illinois, which possesses a much greater range of available mayfly habitats, has nearly three times as many species of mayflies as has Florida.

Dr. Berner's work on the Florida mayflies occupied him over a period of seven years. During this time he was able to study the taxonomy, distribution within the state, habitat preferences, seasonal distribution, and habits of the nymphs and adults of all the Florida species. The resulting mass of information is now succinctly presented in this publication. Keys for identification of the adult and immature forms occurring in Florida and illustrations of diagnostic morphological parts are also included. Twenty-four beautiful full-page illustrations of adults and nymphs are distributed through the text. How few insect groups have been so well worked!

The typography of this volume is beyond reproach, and, obviously, neither effort nor expense was spared in the preparation and reproduction of the superb illustrations.

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